

Environment

CA2 ON

EV

1974

A35

1974
rec'd: Cataloguing Office
Printing Services Branch
Jan. 3 '75

AIR POLLUTION AND THE AUTOMOBILE



Ministry
of the
Environment

Hon. William G. Newman,
Minister

Everett Biggs,
Deputy Minister

Copyright Provisions and Restrictions on Copying:

This Ontario Ministry of the Environment work is protected by Crown copyright (unless otherwise indicated), which is held by the Queen's Printer for Ontario. It may be reproduced for non-commercial purposes if credit is given and Crown copyright is acknowledged.

It may not be reproduced, in all or in part, for any commercial purpose except under a licence from the Queen's Printer for Ontario.

For information on reproducing Government of Ontario works, please contact ServiceOntario Publications at copyright@ontario.ca

AIR POLLUTION AND THE AUTOMOBILE

Automobile exhaust can be dangerous and is a major source of air pollution. In addition to carbon dioxide and water vapour, it contains carbon monoxide, oxides of nitrogen, unburned hydrocarbons and lead.

Carbon monoxide concentrated in an enclosed space can be lethal. Less dangerous but still harmful amounts can build up in conditions of heavy traffic or from faulty exhaust systems.

Oxides of nitrogen and hydrocarbons react under the influence of sunlight to produce photochemical oxidants -- compounds that make the eyes smart and irritate throat and breathing passages. Lead from gasoline added to other sources of lead in the atmosphere is of growing concern to health authorities. General opinion is that present lead levels do not constitute a health hazard. However, there is evidence that the lead level is rising, particularly on the surface of the ground. Lead could therefore eventually become a problem if left unchecked.

Causes of Automotive Pollution

Automotive pollutants result from incomplete burning of fuel. When there is sufficient oxygen, hydrocarbon fuel is completely converted into carbon dioxide and water vapour. Incomplete combustion also produces carbon monoxide, hydrocarbons and oxides of nitrogen.

Incomplete combustion can occur for various reasons -- poor mixing of air and fuel, short combustion time, quenching of the combustion process near a cool chamber wall, dead space where the combustion flame cannot penetrate.

Some of these problems can be eliminated by heating the air or fuel prior to mixing, or replacing the standard carburetor with a fuel injection system.

Crankcase emissions are eliminated by using a closed PCV (positive crankcase ventilation) system that feeds crankcase vapours back to the air intake system to be burned in the combustion chamber.

When a car is stationary, particularly when its engine is hot, gasoline can evaporate through either the fuel tank breather tube or carburetor, becoming another source of automotive pollution. It can be greatly reduced by terminating such tubes and other outlets with an activated charcoal filter that absorbs escaping vapours. When the car engine is started, air is sucked through the charcoal filter, extracting the fuel vapours. The mixture then passes through the air filter into the engine, where it is burned.

Controlling Automotive Pollution

Since January 1, 1971 the control of air pollution from motor vehicles has been a shared federal-provincial responsibility. The federal government now establishes all emission standards for new vehicles and enforces them at the manufacturing level. Provincial governments are responsible for the control of pollution caused by emissions from vehicles after they have been sold.

Prior to 1971, regulations controlling automotive pollution existed only at the provincial level. Ontario, in fact, was the first province to pass legislation in this area. Its initial regulations reduced pollution from 1969 model cars to 50 per cent of that produced by uncontrolled cars. Subsequent regulations for 1970 and 1971 reduced emissions further.

Federal regulations for the 1972 model year have reduced car emissions to 20 per cent of the uncontrolled level, and it is anticipated that this figure will be down to approximately 10 per cent by 1975.

In Ontario, the provincial agency responsible for the control and prevention of air pollution is the Air Resources Branch of the Ministry of the Environment. The control of pollution from motor vehicles is the special responsibility of the Branch's Vehicle Emissions Section.

This Section works in several ways to lessen automotive pollution. It assesses, on a continuing basis, the effectiveness of exhaust emission controls and ensures compliance with the Environmental Protection Act, 1971, by conducting spot-checks on vehicles in various parts of the Province. The act makes it an offence to remove such systems or to operate a vehicle with the system removed or inoperative, and there is a provision for a maximum fine of \$5,000.00. The section also conducts experimental programmes relating to new types of automotive control systems; provides an educational service to automotive mechanics (in the trade and at colleges) to illustrate the importance of the proper use of analytical equipment and proper tune-up procedures in emission reduction; operates a pilot programme to reduce visible emissions from heavy duty vehicles, and promotes public awareness of the necessity to keep vehicles regularly and properly maintained.

Exhaust Control Methods

There are four basic ways of controlling automotive exhausts.

(1) Engine modification systems involve redesign of the engine to produce more efficient combustion and, therefore, lower concentrations of pollutants.

Engines equipped with engine modification systems have carburetors of a leaner air fuel mixture, usually a ratio of approximately 14:1 to 15:1. The spark timing is advanced or retarded for better combustion depending on the particular mode of vehicle operation. Some of the exhaust gas is also recycled through the engine to reduce NO_x formation.

(2) The air injection system uses an air pump to force air into the exhaust manifold of the car engine. The temperature of the air-exhaust gas mixture is high enough to induce more complete combustion. As a result, most of the polluting gases are burnt to carbon dioxide and water vapour.

(3) The fuel injection system accurately meters a fixed amount of fuel and air to each combustion chamber of the vehicle's engine. Better combustion can be achieved with this approach than with the carburetor system. Fuel injection cuts off the fuel supply completely during deceleration, a time when a carburetor causes high pollutant output.

(4) Catalytic mufflers containing certain types of catalysts can be used to oxidize carbon monoxide and hydrocarbons or to reduce oxides of nitrogen. Due to the poisoning effect that lead has on the catalyst, however, the system can only be used with unleaded gasoline, gaseous fuels (e.g. liquid propane) or diesel fuel.

In the past few years there have been a number of encouraging developments in the area of automotive pollution control. A large public utility has tested dual-fuel vehicles. These cars use gasoline on the

open highway and either propane or natural gas in congested areas and stop-and-go traffic. However, although this does reduce the emission of pollutants, it has one disadvantage. For best fuel economy, the carburetion system requires different settings for combustion of gasoline and gaseous fuel. Therefore, in order to operate on both fuels alternately, the setting must be at an intermediate position, giving a less economic use of both fuels.

Tests have suggested that car engines using natural gas or propane can operate with lower emissions and for considerably greater mileages between maintenance checks than those using gasoline. This is due to an absence of both spark plug fouling and engine oil dilution. However, due to problems of fuel distribution, this type of system is likely to be of benefit only to fleet operators whose vehicles return each night to a central refuelling point. It is unlikely to become the everyday fuel for the average motorist.

The use of lead-free and low-lead gasoline in existing vehicles is not expected to significantly reduce emissions of the main gaseous pollutants -- carbon monoxide and hydrocarbons -- although a number of conflicting reports have been issued on this topic.

Some reports state that the use of lead-free fuel increases the emission of hydrocarbons, particularly those with high photochemical smog-forming potential. Other reports indicate that the use of such fuel will bring about a decrease in hydrocarbon emissions. On this latter point, however, there is additional conflict whether fuel can be low-lead or must be completely lead-free before hydrocarbon emissions are reduced.

Vehicles can be split into three groups in reference to their ability to use lead-free gasoline. In the following cases, it is assumed that a lead-free gasoline of sufficiently high octane number is available

to satisfy the octane requirement of an engine as a result of its compression ratio.

(1) Pre-1971 North American vehicles which have been operated for a considerable period of time on leaded gasoline possess a protective layer of lead on various engine parts. A switch to unleaded fuel should produce no adverse effects.

(2) North American vehicles sold late in the 1970 model year plus 1971 and later Asian and European imports will not be adapted to operate on unleaded fuel. Use of this type of fuel from the very beginning of engine operation could give rise to severe engine malfunction. A possible solution is to operate such vehicles for a few hundred miles on leaded fuel, followed by general use of unleaded gasoline. It will probably be necessary to repeat the use of leaded gasoline at intervals to ensure a replacement of the protective lead coating.

(3) 1971 and later model North American vehicles have for the most part been manufactured for satisfactory operation on 91 octane, lead-free gasoline. Use of this fuel poses no problem.

The use of lead-free gasoline will help reduce the total amount of lead being emitted into the atmosphere. In addition, lead-free gasolines are necessary for the satisfactory operation of catalytic mufflers -- that will be used by certain manufacturers to ensure compliance with federal emission standards proposed for 1975. General Motors has already stated that it intends to install catalytic mufflers on all of its cars from 1975 onwards.

Alternatives to the Internal Combustion Engine

Possible alternatives to the internal combustion engine are an electric power source, a modified steam engine and the gas turbine.

The totally electric car is not considered a feasible solution at present. It is of necessity small because of low power availability. In addition, the considerable weight of the power source (set of batteries) and the volume it occupies leaves both very little power and room for transportation of goods, luggage, etc.

The electric car has a top speed of about 50 m.p.h. and a small range (about 40 miles at 50 m.p.h. and 65 miles at 30 m.p.h.). As a result, it is limited to urban driving. Battery recharging time is considerable.

Possessing definite potential is the gasoline-electric hybrid. Several types have been produced on an experimental basis. Electric power is used for urban driving during which low maximum speed is not a great disadvantage. At the same time the high pollution levels created by gasoline powered vehicles while idling or travelling at low speeds are eliminated.

Outside urban areas, when high speeds are necessary, the hybrid is switched over to gasoline. Emissions from gasoline engines are much lower at high speeds. Part of the power generated is used to recharge the batteries.

The steam or Rankin engine works on the same principle as the regular steam engine. Recently developed propulsion systems cannot really be termed "steam", however, because the water component has been replaced by various low boiling point organic compounds of the type used in refrigerators (freon, etc.).

This engine burns fuel very cleanly, producing only about one per cent of the emissions of a gasoline engine. Speeds are comparable with those of conventional vehicles. As an external combustion engine it can burn any fuel. Kerosene is generally used. However, although the

combustion is almost complete, producing minimal amounts of pollution, the efficiency is lower than with diesel engines, and fuel economy is a problem.

Much development work was done on this engine several years ago. Many difficulties persisted, however, and not all of them have been resolved. This approach has lost much of the promise that it once held out as a possible pollution-free alternative to the internal combustion engine.

The gas turbine has been tested several times as a propulsion unit for the automobile. Difficulties include noise, slow acceleration, vehicle vibration and engine weight and size. Pollutant output is considerably less than that resulting from a gasoline engine and still somewhat less than that from a diesel engine. Concentration figures for exhaust components cannot be meaningfully compared, however, due to dilution of gas turbine exhaust with large quantities of excess air.

The gas turbine engine seems more suitable as a power unit for trucks and busses, and some progress has recently been made in this area of application.

This publication was prepared by J.G. Jefferies, Supervisor, Vehicle Emissions Section, Air Resources Branch, Ontario Ministry of the Environment.

First Printing:	March 1971
Revised:	January 1972
Third Printing:	November 1972
Fourth Printing:	August 1973
Revised:	October 1974

LEGISLATIVE LIBRARY OF ONTARIO



9693600020245



Ontario

Ministry
of the
Environment

Published by
Information Services Branch
135 St. Clair Avenue West
Toronto, Ontario
M4V 1P5